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ALGEBRA.

Conducted by J. M. COLAW, Monterey, Va. All contributions to this department should be sent to him.

SOLUTIONS OF PROBLEMS.

60. Proposed by ROBERT J. ALEY, A. M., Professor of Mathematics in Indiana University, Bloomington, Indiana.

Telegraph poles are a yards apart; for how many minutes must one count poles in order that the number of poles counted may be equal to the number of miles per hour that the train is running?

I. Solution by FREDERICK R. HONEY, A. B., New Haven, Connecticut.

The problem is independent of the number of poles counted, and of the number of miles per hour the train is running. We will call this number N.

$\therefore aN=$the number of yards the train runs while the poles are counted. Also, $1760N=$number of yards per hour the train runs. $\therefore aN/1760N=$the fraction of an hour during which the poles are counted.

$\therefore 60aN/1760N=3a/88=$number of *minutes* during which the poles are counted.

II. Solution by M. A. GRUBER, A. M., War Department, Washington, D. C.; and W. H. CARTER, Professor of Mathematics, Centenary College of Louisiana, Jackson, Louisiana.

Let $x=$the number of minutes, and let $r=$number of miles per hour the train is running. Also, $1760/a=$number of poles in a mile, and $rx/60=$number of miles the train runs in x minutes. Then, $rx/60\times1760/a=88rx/3a=$number of poles passed in x minutes, or while the train is running $rx/60$ miles.

$\therefore 88rx/3a=r$; whence $x=3a/88$.

The number of minutes depends upon the distance the poles are apart irrespective of the rate of the train.

Also solved by *O. W. ANTHONY, P. S. BERG, A. H. HOLMES, C. D. SCHMITT, H. C. WILKES, B. F. YANNEY*, and *G. B. M. ZERR*.

61. Proposed by COOPER D. SCHMITT, M. A., Professor of Mathematics, University of Tennessee, Knoxville, Tennessee.

Demonstrate the identity $2^{2n+1}\dfrac{d^n}{dx^n}\left(x^{n+\frac{1}{2}}\dfrac{d^{n+1}}{dx^{n+1}}e^{\sqrt{x}}\right)=e^{\sqrt{x}}$.

I. Solution by O. W. ANTHONY, M. Sc., Professor of Mathematics in New Windsor College, New Windsor, Maryland.

It may be proved inductively that $\dfrac{d^n}{dx^n}e^{\sqrt{x}}=\dfrac{1}{4x}\dfrac{d^{n-2}}{dx^{n-2}}e^{\sqrt{x}}-(n-\tfrac{3}{2})\dfrac{d^{n-1}}{dx^{n-1}}e^{\sqrt{x}}$.

Change n to $n+3$; then

$$\frac{d^{n+3}}{dx^{n+3}}e^{\sqrt{x}}=\frac{1}{4x}\frac{d^{n+1}}{dx^{n+1}}e^{\sqrt{x}}-(n+\tfrac{3}{2})\frac{d^{n+2}}{dx^{n+2}}e^{\sqrt{x}}.$$

Clearing of fractions and transposing,

$$\frac{d^{n+1}}{dx^{n+1}}e^{\sqrt{x}}=4(n+\tfrac{3}{2})\frac{d^{n+2}}{dx^{n+2}}e^{\sqrt{x}}+4x\frac{d^{n+3}}{dx^{n+3}}e^{\sqrt{x}}.$$

Multiply through by $x^{n+\frac{1}{2}}$, and we have

$$x^{n+\frac{1}{2}}\frac{d^{n+1}}{dx^{n+1}}e^{\sqrt{x}}=4[(n+\tfrac{3}{2})x^{n+\frac{1}{2}}\frac{d^{n+2}}{dx^{n+2}}e^{\sqrt{x}}+x^{n+\frac{3}{2}}\frac{d^{n+3}}{dx^{n+3}}e^{\sqrt{x}}]$$

$$=4\frac{d}{dx}[x^{n+\frac{3}{2}}\frac{d^{n+2}}{dx^{n+2}}e^{\sqrt{x}}].$$

Multiply through by 2^{2n+1} and differentiate n times, and we have

$$2^{2n+1}\frac{d^n}{dx^n}(x^{n+\frac{1}{2}}\frac{d^{n+1}}{dx^{n+1}}e^{\sqrt{x}})=2^{2n+3}\frac{d^{n+1}}{dx^{n+1}}(x^{n+\frac{3}{2}}\frac{d^{n+2}}{dx^{n+2}}e^{\sqrt{x}}).$$

Hence, if the form given is true for n, it will be true for $n+1$. It may be easily verified that it is true for $n=2$. Therefore it is *generally* true.

II. Solution by HENRY HEATON, M. S., Atlantic, Iowa, and G. B. M. ZERR, A. M., Ph. D., Professor of Mathematics and Applied Science, Texarkana College, Texarkana, Arkansas-Texas.

$$\frac{d}{dx}e^{\sqrt{x}}=\frac{e^{\sqrt{x}}}{2\sqrt{x}},\ \frac{d^2}{dx^2}e^{\sqrt{x}}=\frac{e^{\sqrt{x}}(\sqrt{x}-1)}{4x^{\frac{3}{2}}},\ \frac{d^3}{dx^3}e^{\sqrt{x}}=\frac{e^{\sqrt{x}}(x-3\sqrt{x}+3)}{8x^{\frac{5}{2}}},$$

$$\frac{d^4}{dx^4}e^{\sqrt{x}}=\frac{e^{\sqrt{x}}(x^{\frac{3}{2}}-6x+15\sqrt{x}-15)}{16x^{\frac{7}{2}}}.\quad \therefore x^{\frac{5}{2}}\frac{d^3}{dx^3}e^{\sqrt{x}}=\frac{e^{\sqrt{x}}(x-3\sqrt{x}+3)}{8}.$$

$$\frac{d}{dx}\{x^{\frac{5}{2}}\frac{d^3}{dx^3}e^{\sqrt{x}}\}=\tfrac{1}{16}e^{\sqrt{x}}(\sqrt{x}-1),\ 2^5\frac{d^2}{dx^2}\{x^{\frac{5}{2}}\frac{d^3}{dx^3}e^{\sqrt{x}}\}=e^{\sqrt{x}}.$$

$$\text{Also } x^{\frac{7}{2}}\frac{d^4}{dx^4}e^{\sqrt{x}}=\tfrac{1}{16}e^{\sqrt{x}}(x^{\frac{3}{2}}-6x+15\sqrt{x}-15).$$

$$\frac{d}{dx}\{x^{\frac{7}{2}}\frac{d^4}{dx^4}e^{\sqrt{x}}\}=\tfrac{1}{32}e^{\sqrt{x}}(x-3\sqrt{x}+3),$$

$$\frac{d^2}{dx^2}\{x^{\frac{7}{2}}\frac{d^4}{dx^4}e^{\sqrt{x}}\}=\tfrac{1}{64}e^{\sqrt{x}}(\sqrt{x}-1),\ 2^7\frac{d^3}{dx^3}\{x^{\frac{7}{2}}\frac{d^4}{dx^4}e^{\sqrt{x}}\}=e^{\sqrt{x}}.$$

Hence generally $2^{2n+1}\frac{d^n}{dx^n}\{x^{n+\frac{1}{2}}\frac{d^{n+1}}{dx^{n+1}}e^{\sqrt{x}}\}=e^{\sqrt{x}}$.

Also solved by *B. F. YANNEY*.

PROBLEMS.

70. Proposed by J. A. CALDERHEAD, A. B., Professor of Mathematics, Curry University, Pittsburg, Pennsylvania.

Given $\sqrt[3]{a+x}+\sqrt[3]{a-x}=\sqrt[3]{c}$ to find x.

71. Proposed by F. P. MATZ, D. Sc., Ph. D., Professor of Mathematics and Astronomy in Irving College, Mechanicsburg, Pennsylvania.

When $x=0$, find the the limit of the expression

$$U=\left(\frac{m+x}{m-x}\right)^{\frac{1}{x}}+\left(\frac{m-x}{m+x}\right)^{\frac{1}{x}}.$$

GEOMETRY.

Conducted by B. F. FINKEL, Springfield, Mo. All contributions to this department should be sent to him.

SOLUTIONS OF PROBLEMS.

54. Proposed by I. J. SCHWATT, Ph. D., University of Pennsylvania, Philadelphia, Pennsylvania.

Prove geometrically:

If through the center of perspective D of a given triangle ABC and its Brocard triangle $A'B'C'$ be drawn straight lines so as to pass through S_a, S_b and S_c (S_a, S_b, and S_c are the middle points of the sides BC, AC, and AB of the triangle ABC) and if S_aA_1 is made equal to DS_a, S_bD_2 equal to DS_b, and S_cD_3 equal to DS_c then are (1) the figures $D_1O'AO$, $D_2O'BO$ and $D_3O'CO$ parallelograms (O and O' are Brocard's points), (2) the triangles $D_1D_2D_3$ and ABC are equal, and (3) D_1A, D_2B, and D_3C intersect in S, (S is the middle point of OO').

Solution by G. B. M. ZERR, A. M., Ph. D., Professor of Mathematics and Applied Science, Texarkana College, Texarkana, Arkansas-Texas.

Since AC, DD_2 and BC, DD_1 bisect each other the quadrilaterals $ADCD_2$ and $BDCD_1$ are parallelograms, and AD_2, BD_1 both being equal and parallel to DC are equal and parallel to each other. Hence ABD_1D_2 is a parallelogram and AB is equal and parallel to D_1D_2. Similarly, AC is equal and parallel to D_1D_3, and BC is equal and parallel to D_2D_3.

$\therefore$ Triangle ABC is equal to triangle $D_1D_2D_3$. Also AD_1, BD_2, and